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White Fir

An American Wood

Six species and one variety of true fir in western North America are commercially important trees whose woods are grouped together and sold as white fir by the wood industry. White fir wood is light in weight and is manufactured primarily into lumber, plywood for construction and industrial use, and wood pulp for paper manufacture. Construction uses include framing, sheathing, concrete forms, roof decking, and siding. Industrial uses include industrial crating and shook, pallet stock, furniture parts, and laminated wood products.

F-508933

White Fir
(*Abies* spp.)

Donald C. Markstrom and Sue E. McElderry[1]

Commercial Species and Names

North American members of the genus *Abies* are called true firs to distinguish them from Douglas-fir, which belongs to the genus *Pseudotsuga*. There are six species and one variety of true fir in western North America that produce commercially valuable timber. Because of similarities in appearance and properties, the woods of these species are combined and sold as white fir by the wood industry. This term should not be confused with the common name of *Abies concolor*, the white fir tree, whose wood is also included in this lumber group.

In this leaflet, the term white fir group is used when referring to the wood of all species included in the commercial designation. The accepted common name of the tree is used when an individual species is discussed; the accepted common name has been selected by the Tree and Range Plant Name Committee of the U.S. Department of Agriculture Forest Service in an effort to standardize the common names of trees. The following is a list of trees included in the white fir group.

Scientific name	Accepted common name	Other names
Abies amabilis	Pacific silver fir	silver fir Cascades fir red fir white fir
Abies concolor	white fir	balsam fir Colorado fir silver fir white balsam
Abies grandis	grand fir	balsam fir giant fir lowland white fir silver fir white fir yellow fir
Abies lasiocarpa	subalpine fir	alpine fir balsam Rocky Mountain fir white fir
A. lasiocarpa var. *arizonica*	corkbark fir	Arizona fir cork fir white fir
Abies magnifica	California red fir	Shasta red fir red fir silver tip white fir
Abies procera	noble fir	red fir white fir

Distribution and Growth Characteristics

All species of the white fir group grow in the Pacific Coast States. Pacific silver fir and subalpine fir extend northward along the coast into southeastern Alaska. In addition to growing in the Pacific Coast States, grand fir also grows in the northern Rockies, extending into British Columbia. Subalpine fir is found throughout the Rocky Mountains and in the Southwest; white fir and corkbark fir are present in the southern Rockies and the Southwest.

In general, the true firs have flattened needles that are 3/4 to 1-1/2 inches long. White fir (fig. 1) has exceptionally long, 2- to 3-inch needles. Unlike the other true firs, needles of noble fir and California red fir are four-sided rather than flattened.

The cones of true firs are cylindrical to barrel-shaped and are borne erect on the uppermost branches. Grand, subalpine, and corkbark firs have cones 2 -1/4 to 4 -1/4 inches long, while those of California red fir are 6 to 9 inches long. The other trees in this group have cones intermediate in length. When they mature, the cones do not open; instead, the scales fall off, releasing the seeds and leaving the spikelike central axes standing on the branch.

Distribution and growth characteristics vary considerably among the individual species and are discussed separately.

White Fir, *Abies concolor* (Gord. & Glend.) Lindl. ex Hildebr.—White fir is found in a variety of climatic situations across its geographic range. At high elevations in the Rocky Mountains, growing seasons are short and the snowpack is moderate to heavy. Summers tend to be wetter in the Southwest than in the central Rockies, where rainfall is distributed more evenly throughout the spring and summer. In the

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Coastal States, the growing season is dry. Fall and early spring rains account for most of the precipitation at low elevations, while higher up most moisture comes from winter snowpack. White fir grows at elevations as low as 2,000 feet in Oregon and as high as 11,000 feet in the interior portion of its range (fig. 2).

White fir is commonly found growing with other species that vary with latitude, elevation, and site. In the Coastal States, associates include ponderosa, Jeffrey, and sugar pines; grand and California red firs; Douglas-fir; and incense-cedar. In the Rocky Mountains and Southwest, white fir is found with Douglas-fir, ponderosa pine, blue and Engelmann spruces, quaking aspen, and subalpine and corkbark firs.[2]

White fir seedlings are shade tolerant, but once established, they grow best in full sunlight. Growth may be slow the first 5 years or longer. In the Coastal States, trees 40 to 65 inches in diameter and 130 to 180 feet tall are not unusual. In the Southwest, trees average about 50 inches in diameter and 135 feet tall. The record white fir is 107 inches in diameter and 192 feet tall. Near the coast, white fir does not often exceed 350 years of age, but 500-year-old individuals have been reported. Maximum ages in the interior may be nearly 300 years.

The most serious pest of white fir is the fir engraver, a beetle that causes considerable damage and mortality. Various defoliators, including the Douglas-fir tussock moth and western spruce budworm, reduce growth and kill some trees.[3] Partial cutting, which leaves the tree unprotected by neighbors, or the weakening effects of rot may predispose this shallow-rooted species to windthrow. White fir, like the other true firs, is susceptible to dwarf mistletoe infestation. Browsing by big game may retard height growth for many years.

Figure 1—Foliage, cone, and bark of white fir (*Abies concolor*). F-222502

Grand Fir, *Abies grandis* (Dougl. ex D. Don) Lindl.—Climate across the range of grand fir is quite variable (fig. 3). Annual precipitation may be as low as 14 inches in eastern Oregon and as high as 100 inches in western Washington. Only 15 to 25 percent of the total precipitation occurs during the growing season. Snowfall is greater in the interior mountains than nearer the coast. Grand fir may be found near sea level in British Columbia and as high as 5,000 feet in portions of Oregon and Idaho.

Grand fir grows in pure stands in north-central Idaho. Elsewhere, it is usually found in mixture with other species. Its associates include Douglas-fir, western larch, western redcedar, western hemlock, Sitka spruce, redwood, and ponderosa, lodgepole, and western white pines.

Grand fir seedlings are shade tolerant, but after age 20 to 30 years, the most rapid growth is attained in the open. Trees in coastal forests reach 24 to 48 inches in diameter and 140 to 160 feet in height. The record specimen is 79 inches in diameter and 231 feet tall. Rapid early height growth has produced 140-foot trees at 50 years. The maximum reported age is 280 years.

The susceptibility of grand fir to heartrot and decay results in appreciable losses of merchantable volume.

[2]For the scientific names of these trees and other trees mentioned in this publication, see the appendix.

[3]For the scientific names of these insects and other insects mentioned in this publication, see the appendix.

The western spruce budworm and Douglas-fir tussock moth cause widespread defoliation, dieback, and mortality. The fir engraver, western balsam bark beetle, and balsam woolly aphid all contribute to mortality.

California Red Fir, *Abies magnifica* A. Murr.—In the more northern portions of its range the cones of California red fir sometimes have bracts that are longer than the cone scales. Some taxonomists recognize this form as a separate variety named Shasta red fir (*Abies magnifica* var. *shastensis*). However, these two trees are very similar and intermediate forms occur. Recent studies indicate that Shasta red fir is a hybrid between California red fir and noble fir. Therefore, these two trees are not distinguished here, but are referred to collectively as red fir.

The climate over the geographic range of red fir is characterized by heavy winter snowpacks that contain 80 percent or more of the total annual precipitation (fig. 4). The precipitation supplied by scattered summer thundershowers is negligible, resulting in a 4- to 5-month dry period during the growing season. Over most of its range, red fir grows at elevations between 6,000 and 9,000 feet.

Red fir sometimes forms pure stands. It also may be found in association with Douglas-fir, mountain hemlock, white fir, and ponderosa, Jeffrey, lodgepole, and sugar pines.

Seedlings of red fir are initially shade tolerant, but after establishment, their growth is best in full sunlight. Growth may be slow for the first 5 years or longer. Mature trees commonly attain diameters of 48 to 60 inches and heights of 150 feet. The record specimen is 102 inches in diameter and 180 feet tall. Trees older than 500 years have been reported.

Heart rots result in loss of merchantable volume, and dwarf mistletoe significantly reduces growth. The fir engraver is the most damaging insect pest, but flatheaded and roundheaded fir borers also contribute to mortality. On exposed ridges or after partial cutting, red fir is susceptible to top breakage and windthrow.

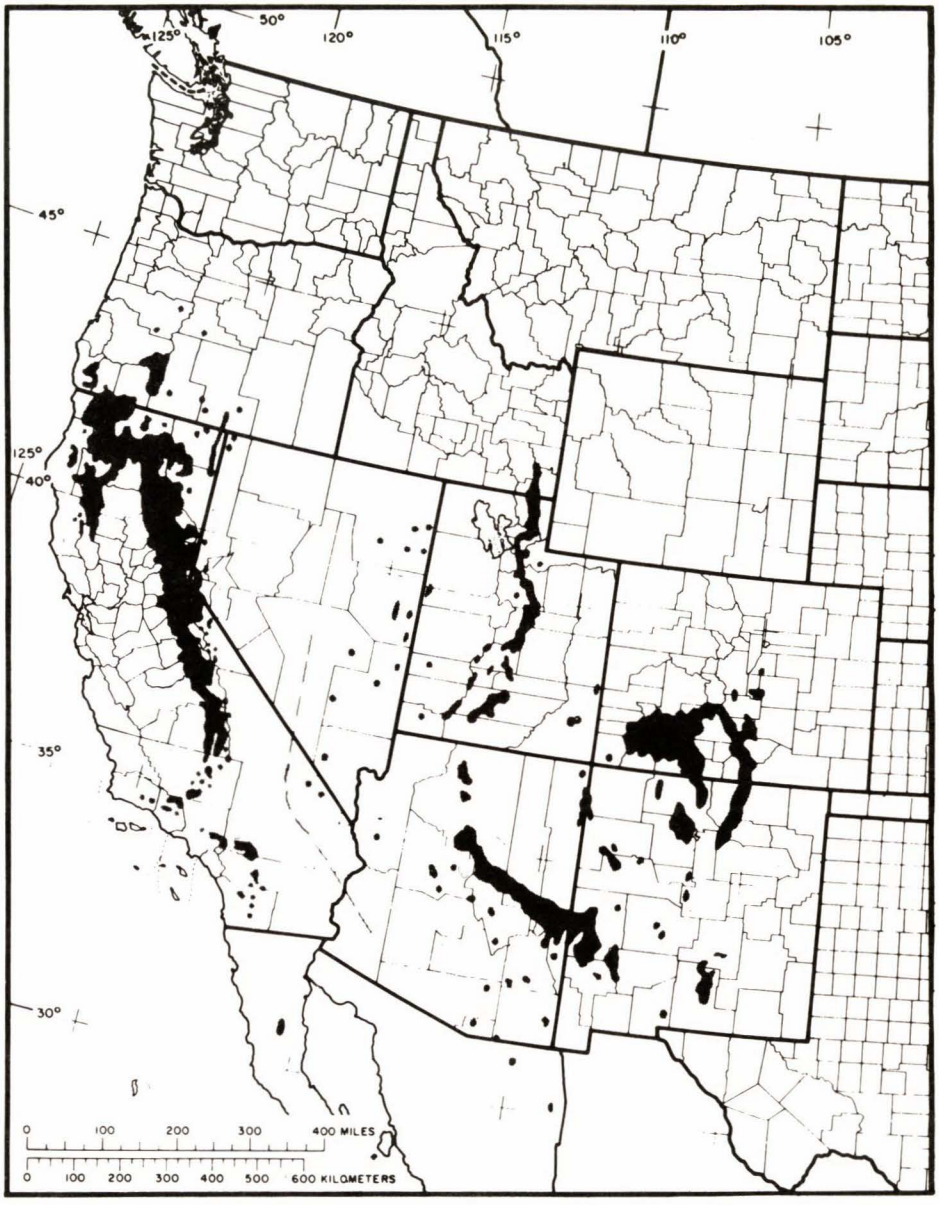

Figure 2—The range of white fir (*Abies concolor*). F-533460

Noble Fir, *Abies procera* Rehd.—Noble fir is found mainly within a superhumid region of relatively cool temperatures and high precipitation (fig. 5). Most of the precipitation falls during the winter, primarily as snow. Over most of its range, noble fir is found at elevations between 3,000 and 5,000 feet.

Noble fir does not form extensive pure stands, but small pure stands are common. It also occurs widely in mixture with other species, most commonly with Douglas-fir, Pacific silver fir, western redcedar, Alaska-cedar, lodgepole and western white pines, and western and mountain hemlocks.

Although seedlings and saplings are moderately shade tolerant, noble fir is considered the least shade tolerant of

the white fir group. Initial seedling growth is typically slower than that of associated species. Seedlings do not develop an early taproot and, therefore, are drought sensitive.

Noble fir attains the largest dimensions of any true fir. The record tree is 108 inches in diameter and 278 feet tall. Mature trees commonly attain diameters of 45 to 60 inches and heights of 130 to 175 feet. This species contains more volume for a given diameter than any of its associates because of its relatively thin bark, slight taper, and large size.

Noble fir is considered the longest lived of the white fir group, with some individuals exceeding 600 years. Mature trees are relatively free of serious insect and disease problems. Noble fir is windfirm because of its deep, spreading root system.

Pacific Silver Fir, *Abies amabilis* Dougl. ex Forbes—Climate throughout the geographic range of Pacific silver fir is characterized by moderate temperatures, humid conditions, a long growing season, and a short, late summer dry period (fig. 6). Winter snowpacks at higher elevations are generally heavy. Pacific silver fir may be found near sea level at the western edge of its range, and up to 6,000 feet in the Cascade Range of south-central Oregon.

This species may form nearly pure stands or grow in mixture with other species. Its associates include western and mountain hemlocks, Douglas-fir, Sitka spruce, and subalpine fir. From seedling to maturity, Pacific silver fir is probably the most shade tolerant of the white fir group.

Seedling growth is very slow, especially in dense shade. Trees 24 or more inches in diameter and 180 to 200 feet tall are common in old growth stands. The record specimen is 101 inches in diameter and 245 feet tall. The maximum age reported for Pacific silver fir is 590 years.

The balsam woolly aphid causes serious mortality in Pacific silver fir. The silver fir beetle and fir root bark beetle also contribute to mortality, and the western hemlock looper and black-headed budworm cause serious defoliation. This species has shallow roots and is susceptible to windthrow, especially after partial cutting.

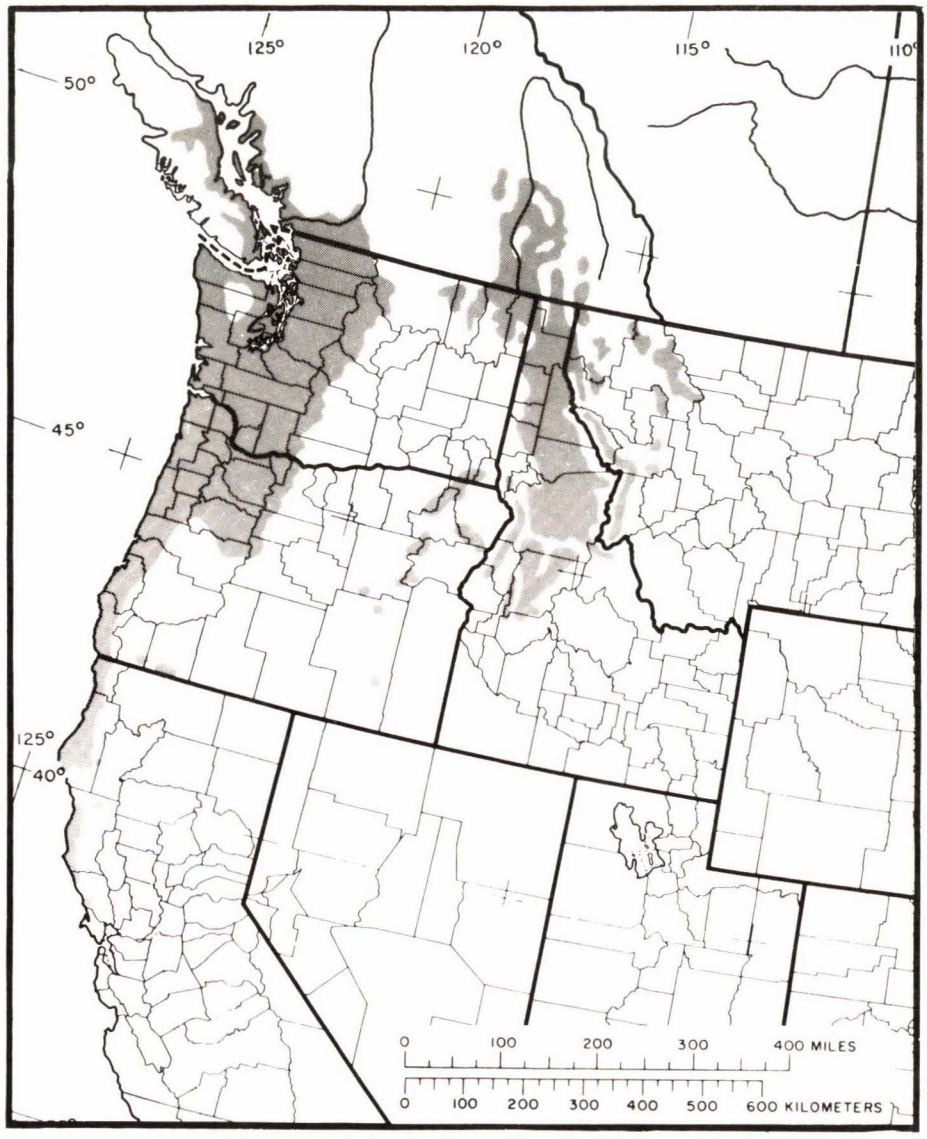

Figure 3—The range of grand fir (*Abies grandis*). F-533400

Subalpine Fir, *Abies lasiocarpa* (Hook.) Nutt. var. *lasiocarpa*, and Corkbark Fir, *Abies lasiocarpa* var. *arizonica* (Merriam) Lemm.—This species is more widely distributed than the other western firs (fig. 7). Subalpine fir has thin, smooth bark, and is found extensively from the Yukon Territory to the Kaibab Plateau in northern Arizona. Corkbark fir, with its thick, corky bark, is restricted to New Mexico, Arizona, and southwestern Colorado, where it occurs with subalpine fir. Because corkbark fir is a variety of subalpine fir, where appropriate, the two will be referred to collectively as subalpine fir.

Subalpine fir is primarily a high elevation species that may be found as high as 12,000 feet in the southern portion of its range. However, at the northern limits of the distribution, it

may be found near sea level. The climate across its range is characterized by short, cool growing seasons and long, generally cold winters with heavy snowpacks.

Limited pure stands of subalpine fir may be found, but it most commonly occurs in mixture with other species. Engelmann spruce is its most common associate in the northern Cascades and throughout the Rocky Mountains. Other associates include mountain hemlock, white and Pacific silver firs, lodgepole and whitebark pines, and quaking aspen.

Shade is important for establishment and early survival of subalpine fir. Early growth is very slow; under favorable conditions, trees reach only 4 to 5 feet in height at 20 to 40 years of age. Mature subalpine firs are typically 12 to 24 inches in diameter and 40 to 100 feet tall with long, narrow, spirelike crowns. The record corkbark fir is 50 inches in diameter and 95 feet tall; the largest known subalpine fir is 80 inches in diameter and 130 feet tall. Trees often live for more than 250 years. On exposed sites near timberline, subalpine fir is often reduced to a stunted shrub form.

The most destructive insect pests of subalpine fir include the western spruce budworm, balsam woolly aphid, western balsam bark beetle, and the fir engraver. Many trees either die or are complete culls at an early age because of various wood-rotting fungi. The species is also susceptible to windthrow, which may be aggravated by topographic exposure and partial cutting.

Supply

The total stand of the sawtimber-size white fir group in the western United States is estimated to be 215 billion board feet. By regions, about 41 percent of the total stand is in the Pacific Northwest, 34 percent in the Pacific Southwest, 18 percent in the northern Rocky Mountains, and 7 percent in the southern Rocky Mountains. By States, about 34 percent of the total stand is in California, 21 percent in Washington, 20 percent in Oregon, and 14 percent in

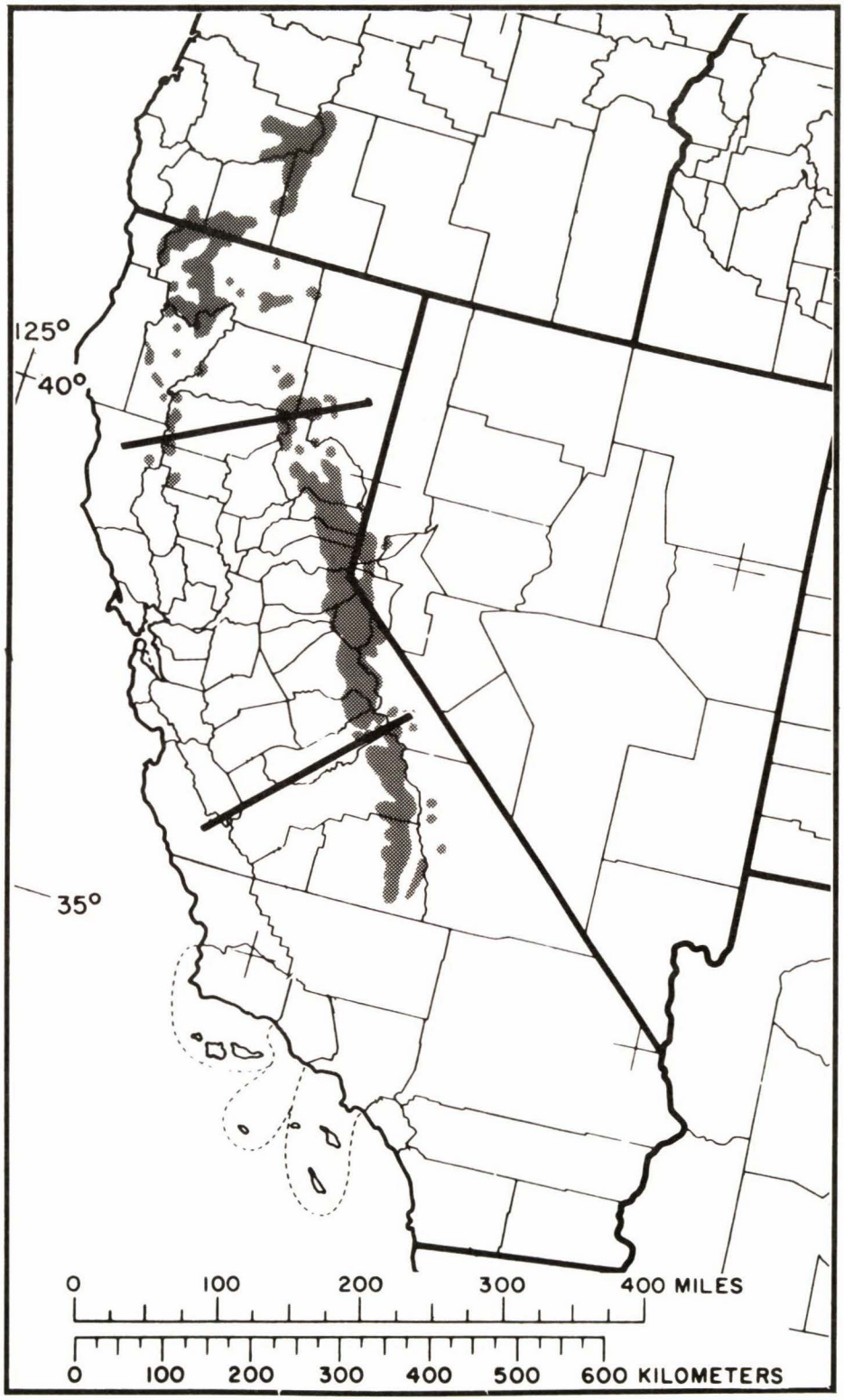

Figure 4—The range of California red fir (*Abies magnifica*). F-533403

Idaho. The remaining 11 percent occurs in other Western States.

Production

Lumber production of the white fir group has fluctuated widely, generally increasing from 1905 to the mid-1960's (fig. 8). Production rose spectacularly from approximately 121 million board feet in 1940 to a record of 2,838 million board feet in 1959. Production since 1959 has lessened and been variable. About 78 percent of the total lumber production in 1976 came from California, Oregon, and Washington. The average production of lumber for the period 1970 through 1979 inclusive was 2,170 million board feet per year. The net annual cut of the white fir group from growing stock during 1976 was estimated at 503 million cubic feet.

Characteristics and Properties

The wood of the white fir group is nearly white to reddish brown, with little or no difference between the sapwood and heartwood. The annual rings show a marked difference in color between the latewood and the earlywood of the succeeding year. The transition from earlywood to latewood is gradual. The wood of this group has a medium to somewhat coarse texture and no normal resin canals. Most of the woods of this group have no characteristic taste or odor when dried, but subalpine fir can have a characteristic odor when damp or when it is rewetted. Wood of the white fir group appears similar to that of western hemlock, except that the color transition from the lighter earlywood to the darker latewood is typically more abrupt in the white firs.

The wood is generally straight grained, relatively easy to work, and stays in place when properly dried. It is one of the important lighter commercial woods of the United States, having an average specific gravity based on green volume and ovendry weight ranging from 0.31 to 0.40, depending on the species. The weight of the white fir group, excluding subalpine fir, averages 27 pounds per cubic foot at 12 percent moisture content; subalpine fir weighs 23 pounds per cubic foot at 12 percent moisture content. The wood is moderate to moderately low in strength, stiffness, ability to resist shock, and in nail withdrawal resistance. The lumber is normally easily dried, but wetwood, a condition caused by bacterial infection, occasionally causes problems that require special handling during the drying process.

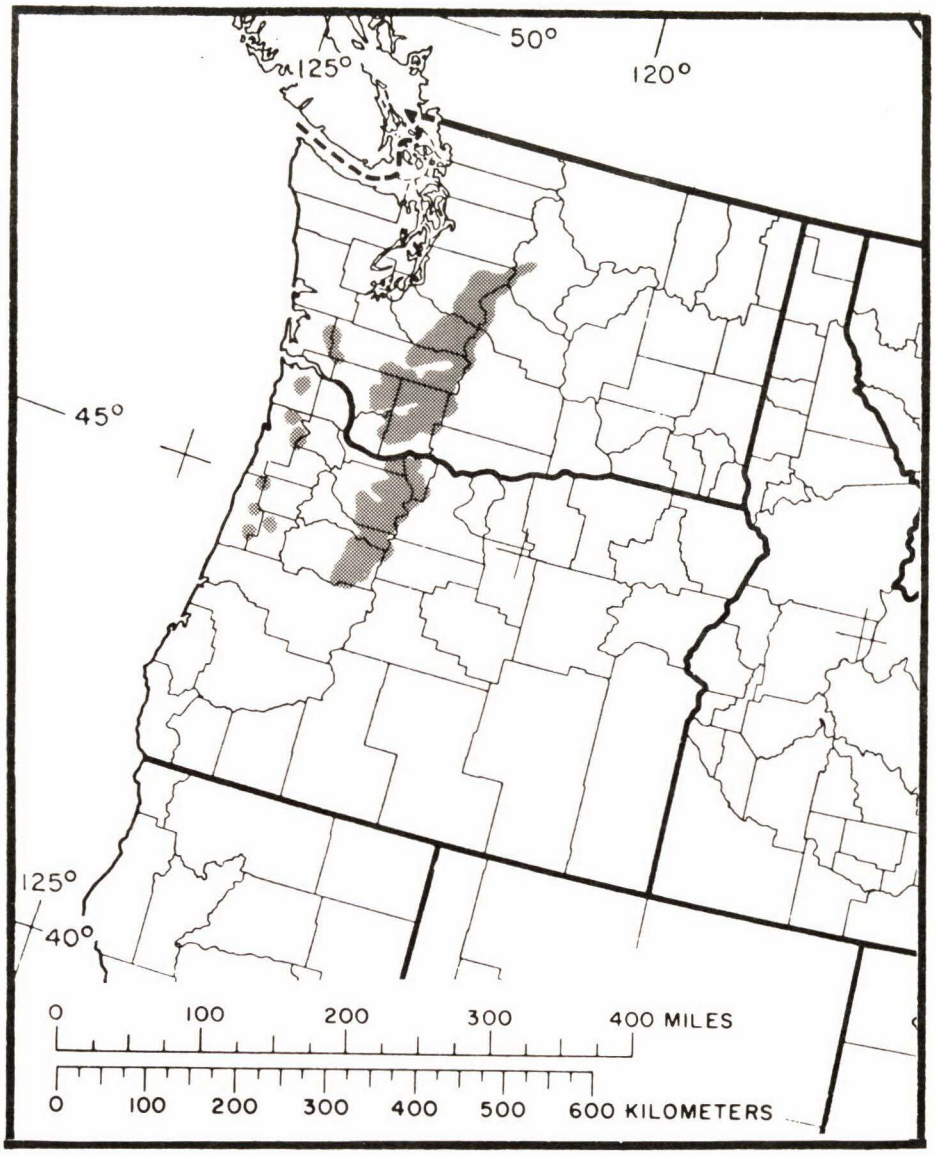

Figure 5—The range of noble fir (*Abies procera*). F-533402

In paint-holding properties, the white fir group is classed with ponderosa pine and western hemlock—below sugar, western white, and eastern white pines, western redcedar, redwood, and baldycypress, but above Douglas-fir and shortleaf, slash, longleaf, loblolly, and Virginia pines. The white fir group, like western redcedar and redwood, is easily glued under a wide range of conditions. The heartwood is not durable when

used under conditions favorable to decay; in this, it ranks with spruce and hemlock. As with practically all other species, the sapwood lacks durability. The wood is considered difficult to penetrate with preservatives.

The lumber from some of the white fir group, especially subalpine fir, is quite likely to contain small knots formed by numerous, persistent small limbs. Consequently, these species yield only minor amounts of high-grade lumber.

Principal Uses

The white fir group is primarily used for lumber, plywood, and pulp in the manufacture of paper. Most of the lumber and plywood is used for construction. For example, during 1965, lumber production reached 2,416 million board feet, and only 380 million was used in remanufacture by industry. Construction uses include framing, sheathing, subflooring, concrete forms, decking, planking, beams, posts, siding, and paneling. Industrial uses include production of millwork, prefabricated buildings and structural members, industrial crating and shook, furniture parts, and mobile homes. Because of its light weight and color, it is especially suitable for fresh fruit and vegetable containers.

All trees in the white fir group can be pulped by any process as easily as spruce, and except for red fir, compare favorably in pulp quality. Red fir yields darker mechanical pulp, and its sulfite and sulfate pulps are more difficult to bleach than those from spruce. The sulfite pulp is suitable for the manufacture of newsprint, light-colored wrapping, book, and other high-grade printing papers. The sulfate pulp is suitable for high-grade kraft wrapping papers and fiberboard. The groundwood pulp is suitable for all uses requiring this type of pulp.

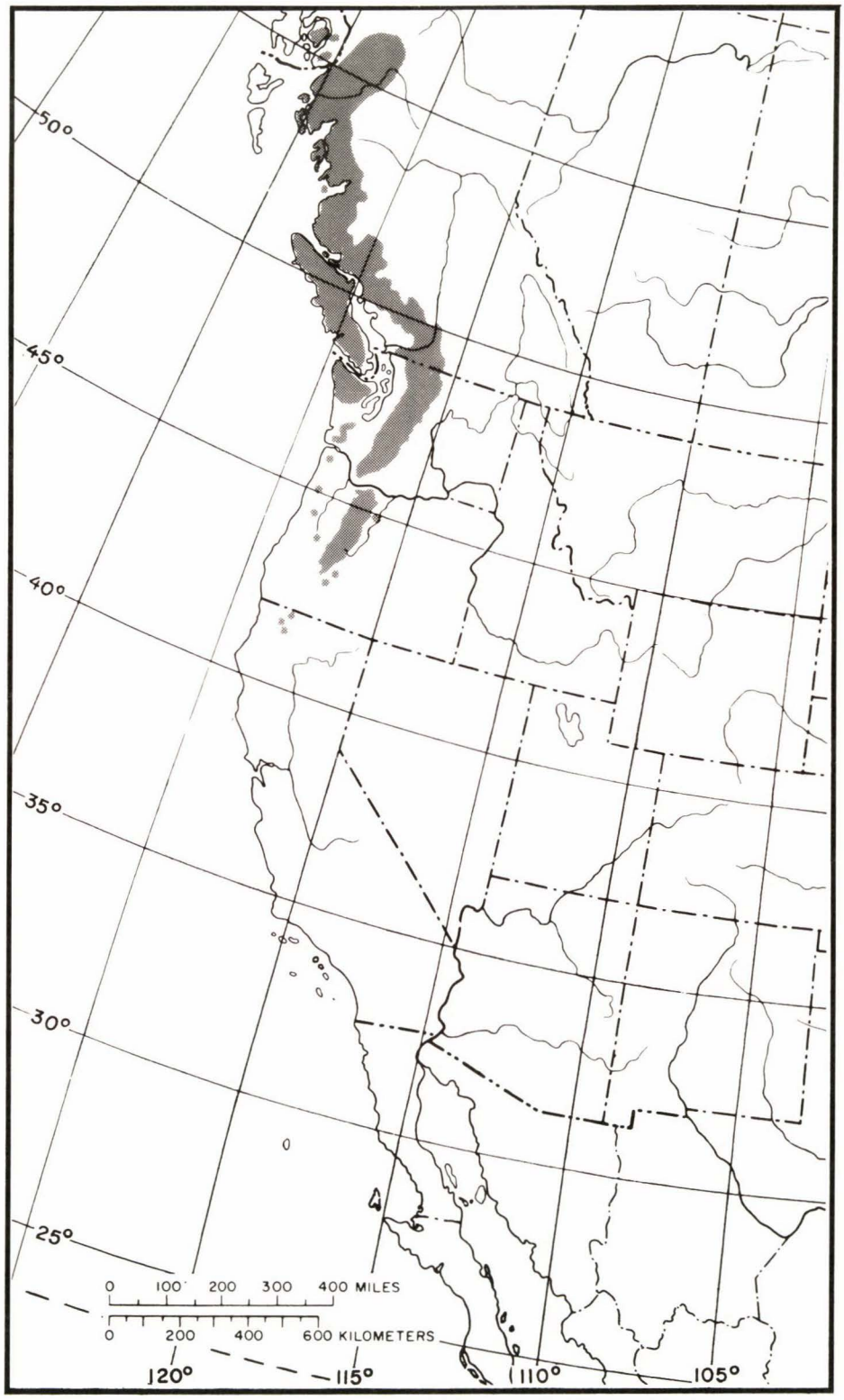

Figure 6—The range of Pacific silver fir (*Abies amabilis*). F-533401

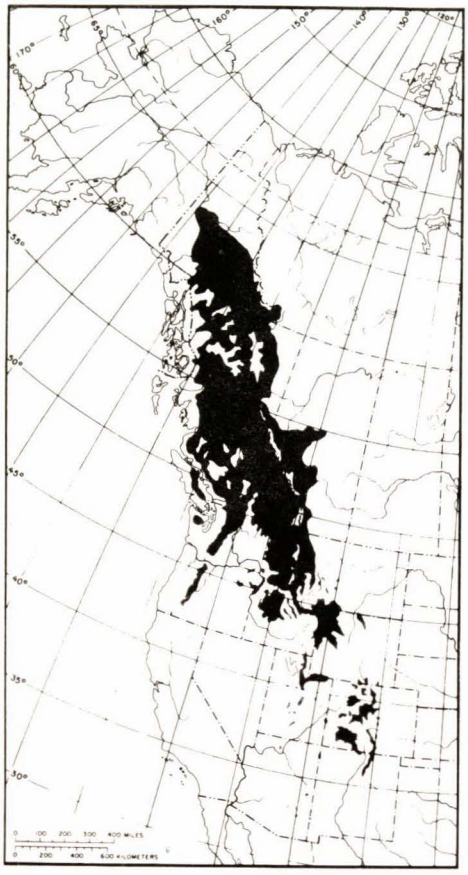

Figure 7—The range of subalpine fir (*Abies*

F-533461

Appendix

Common and scientific names of associated trees and insects mentioned in the text.

Trees

Accepted common names	Scientific name
Alaska-cedar	*Chamaecyparis nootkatensis*
western larch	*Larix occidentalis*
incense-cedar	*Libocedrus decurrens*
Engelmann spruce	*Picea engelmannii*
blue spruce	*Picea pungens*
Sitka spruce	*Picea sitchensis*
whitebark pine	*Pinus albicaulis*
lodgepole pine	*Pinus contorta*
Jeffery pine	*Pinus jeffreyi*
ponderosa pine	*Pinus ponderosa*
quaking aspen	*Populus tremuloides*
Douglas-fir	*Pseudotsuga menziesii*
redwood	*Sequoia sempervirens*
baldcypress	*Taxodium distichum*
western redcedar	*Thuja plicata*
western hemlock	*Tsuga heterophylla*
mountain hemlock	*Tsuga mertensiana*
shortleaf pine	*Pinus echinata*
slash pine	*Pinus elliottii*
longleaf pine	*Pinus palustris*
loblolly pine	*Pinus taeda*
Virginia pine	*Pinus virginiana*
sugar pine	*Pinus lambertiana*
western white pine	*Pinus monticola*
eastern white pine	*Pinus strobus*

Insects

Accepted common name	Scientific name
western blackheaded budworm	*Acleris gloverana*
balsam woolly adelgid	*Adelges piceae*
western spruce budworm	*Choristoneura occidentalis*
western balsam bark beetle	*Dryocoetes confusus*
western hemlock looper	*Lambdina fiscellaria lugubrosa*
flatheaded fir borer	*Melanophila drummondi*
Douglas-fir tussock moth	*Orgyia pseudotsugata*
fir root bark beetle	*Pseudohylesinus granulatus*
silver fir beetle	*Pseudohylesinus sericeus*
fir engraver	*Scolytus ventralis*
roundheaded fir borer	*Tetropium abietis*

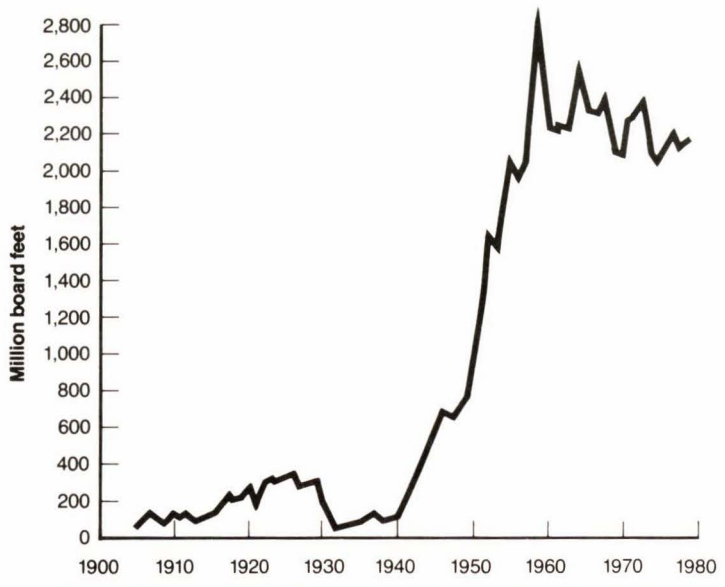

Figure 8—Lumber production of the white fir group, 1905–79.

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